JC950 U.S. PTO 11/07/00

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PTO/SB/05 (4/98)
Approved for use through 09/30/2000. OMB 0651-0032
Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 C.F.R. § 1.53(b))

Attorney Docket No.	41020.P003
First Inventor or Application Identifier	Satoshi Nakajima
Title	M & A For Sending and Receiving A Data Structure In A Constituting Element Occurrence Frequency...
Express Mail Label No.	EL605310990US

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

ADDRESS TO: Assistant Commissioner for Patents, Box Patent Application, Washington, DC 20231

1. [XX] * Fee Transmittal Form *(e.g., PTO/SB/17)* *(Submit an original and a duplicate for fee processing)*
2. [XX] Specification [Total Pages 24] *(preferred arrangement set forth below)*
   - Descriptive title of the Invention
   - Cross References to Related Applications
   - Statement Regarding Fed sponsored R & D
   - Reference to Microfiche Appendix
   - Background of the Invention
   - Brief Summary of the Invention
   - Brief Description of the Drawings *(if filed)*
   - Detailed Description
   - Claim(s)
   - Abstract of the Disclosure
3. [XX] Drawing(s) *(35 U.S.C. 113)* [Total Sheets 7]
4. Oath or Declaration [Total Pages 3]
   a. [XX] Newly executed (original or copy)
   b. [ ] Copy from a prior application (37 C.F.R. § 1.63(d)) *(for continuation/divisional with Box 16 completed)*
      i. [ ] DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 C.F.R. §§ 1.63(d)(2) and 1.33(b).

NOTE FOR ITEMS 1 & 13: IN ORDER TO BE ENTITLED TO PAY SMALL ENTITY FEES, A SMALL ENTITY STATEMENT IS REQUIRED (37 C.F.R. § 1.27), EXCEPT IF ONE FILED IN A PRIOR APPLICATION IS RELIED UPON (37 C.F.R. § 1.28).

5. [ ] Microfiche Computer Program *(Appendix)*
6. Nucleotide and/or Amino Acid Sequence Submission *(if applicable, all necessary)*
   a. [ ] Computer Readable Copy
   b. [ ] Paper Copy (identical to computer copy)
   c. [ ] Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

7. [XX] Assignment Papers (cover sheet & document(s))
8. [ ] 37 C.F.R.§3.73(b) Statement *(when there is an assignee)* [XX] Power of Attorney
9. [ ] English Translation Document *(if applicable)*
10. [ ] Information Disclosure Statement (IDS)/PTO-1449 [ ] Copies of IDS Citations
11. [ ] Preliminary Amendment
12. [XX] Return Receipt Postcard (MPEP 503) *(Should be specifically itemized)*
13. [XX] * Small Entity Statement(s) *(PTO/SB/09-12)* [ ] Statement filed in prior application, Status still proper and desired
14. [ ] Certified Copy of Priority Document(s) *(if foreign priority is claimed)*
15. [ ] Other: .....

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☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) of prior application No: _____/_____

Prior application information: Examiner _____ *Group / Art Unit:* _____

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17. CORRESPONDENCE ADDRESS

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Name (Print/Type)	Aloysius T.C. AuYeung	Registration No. (Attorney/Agent)	35,432
Signature		Date	11-7-2000

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See 37 C.F.R. §§ 1.27 and 1.28.

TOTAL AMOUNT OF PAYMENT ($) 489.00

Complete if Known	
Application Number	Not yet assigned
Filing Date	November 7, 2000
First Named Inventor	Satoshi Nakajima
Examiner Name	
Group / Art Unit	
Attorney Docket No.	41020.P003

METHOD OF PAYMENT (check one)

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FEE CALCULATION

1. BASIC FILING FEE

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
101	690	201	345	Utility filing fee	355.00
106	310	206	155	Design filing fee	
107	480	207	240	Plant filing fee	
108	690	208	345	Reissue filing fee	
114	150	214	75	Provisional filing fee	

SUBTOTAL (1) ($) 355.00

2. EXTRA CLAIM FEES

	Extra Claims		Fee from below	Fee Paid
Total Claims 26	-20** = 6	X	9.00	= 54.00
Independent Claims 4	- 3** = 1	X	40.00	= 40.00
Multiple Dependent				=

**or number previously paid, if greater, For Reissues, see below

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description
103	18	203	9	Claims in excess of 20
102	78	202	39	Independent claims in excess of 3
104	260	204	130	Multiple dependent claim, if not paid
109	78	209	39	** Reissue independent claims over original patent
110	18	210	9	** Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) ($) 94.00

FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
105	130	205	65	Surcharge - late filing fee or oath	
127	50	227	25	Surcharge - late provisional filing fee or cover sheet.	
139	130	139	130	Non-English specification	
147	2,520	147	2,520	For filing a request for reexamination	
112	920*	112	920*	Requesting publication of SIR prior to Examiner action	
113	1,840*	113	1,840*	Requesting publication of SIR after Examiner action	
115	110	215	55	Extension for reply within first month	
116	380	216	190	Extension for reply within second month	
117	870	217	435	Extension for reply within third month	
118	1,360	218	680	Extension for reply within fourth month	
128	1,850	228	925	Extension for reply within fifth month	
119	300	219	150	Notice of Appeal	
120	300	220	150	Filing a brief in support of an appeal	
121	260	221	130	Request for oral hearing	
138	1,510	138	1,510	Petition to institute a public use proceeding	
140	110	240	55	Petition to revive - unavoidable	
141	1,210	241	605	Petition to revive - unintentional	
142	1,210	242	605	Utility issue fee (or reissue)	
143	430	243	215	Design issue fee	
144	580	244	290	Plant issue fee	
122	130	122	130	Petitions to the Commissioner	
123	50	123	50	Petitions related to provisional applications	
126	240	126	240	Submission of Information Disclosure Stmt	
581	40	581	40	Recording each patent assignment per property (times number of properties)	40.00
146	690	246	345	Filing a submission after final rejection (37 CFR § 1.129(a))	
149	690	249	345	For each additional invention to be examined (37 CFR § 1.129(b))	

Other fee (specify) _____

Other fee (specify) _____

* Reduced by Basic Filing Fee Paid

SUBTOTAL (3) ($) 40.00

SUBMITTED BY				Complete (if applicable)	
Name (Print/Type)	Aloysius T. C. AuYeung	Registration No. (Attorney/Agent)	35,432	Telephone	(503) 534-2800
Signature				Date	11-7-2000

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Applicant or Patentee: Satoshi Nakajima
Serial or Patent No.: not yet assigned
Filed or Issued:
Attorney's Docket No. 041020 P003
For: **Method and Apparatus For Sending and Receiving A Data Structure In A Constituting Element Occurrence Frequency Based Compressed Form**

VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS
37 CFR 1.9 (f) and 1.27(c) - - SMALL BUSINESS CONCERN

I hereby declare that I am:

[XX] the owner of the small business concern identified below
[____] an official of the small business concern empowered to act on behalf of the concern identified below:

NAME OF CONCERN: UI EVOLUTION INC
ADDRESS OF CONCERN: 155 108TH AVE., NE, SUITE 405
BELLEVUE, WA 98004

I hereby declare that the above identified small business concern qualifies as a small business concern as defined in 13 CFR 121.3-18, and reproduced in 37 CFR 1.9(d), for purposes of paying reduced fees under Section 41(a) and (b) of Title 35, United States Code, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full-time, part-time or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.

I hereby certify that to the best of my knowledge and belief rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the invention entitled **Method and Apparatus For Sending and Receiving A Data Structure In A Constituting Element Occurrence Frequency Based Compressed Form**
by inventor(s) Satoshi Nakajima
described in

[____] the specification being filed herewith
[____] application serial no _____, filed _____
[____] patent no. _____, issued _____

and I have reviewed the document that evidences the conveyance of those rights. That document

[____] is being filed herewith.
[____] was recorded in the Patent and Trademark Office on _____, 19__ at reel _____ and frame _____.

If the rights held by the above-identified small business concern are not exclusive, each individual, concern or organization having rights to the invention is listed below and **no rights to the invention are held by any person, other than the inventor, who could not qualify as a small business concern under 37 CFR 1.9(d) or by any concern which would not qualify as a small business concern under 347 CFR 1.9(d) or a non-profit organization under 37 CFR 1.9(e).** NOTE: Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities. (37 CFR 1.27)

NAME: _____
ADDRESS: _____
[____] Individual [____] Small Business Concern [____] Non-Profit Organization
NAME: _____
ADDRESS: _____
[____] Individual [____] Small Business Concern [____] Non-Profit Organization

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

NAME OF PERSON SIGNING. SATOSHI NAKAJIMA
TITLE OF PERSON OTHER THAN OWNER: PRESIDENT & CEO
ADDRESS OF PERSON SIGNING: 155 108TH AVE., NE, SUITE 405, BELLEVUE, WA 98004

SIGNATURE: ____________ DATE: 11/6/2000

Our Ref.: 41020.P003

APPLICATION FOR UNITED STATES LETTERS PATENT

FOR

Method And Apparatus For Sending and Receiving A Data Structure In A Constituting Element Occurrence Frequency Based Compressed Form

Inventor(s):
Satoshi Nakajima

Prepared by:

COLUMBIA IP LAW GROUP, LLC
LAKE OSWEGO, OR & KIRKLAND, WA

"Express Mail" label number EL605310990US

Method and Apparatus for Sending and Receiving A Data Structure in a Constituting Element Occurrence Frequency Based Compressed Form

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to the fields of data processing. More specifically, the present invention relates to the sending and receiving of data structures in a bandwidth reduction form.

2. Background Information

Recently, with advances in the Internet and web based applications, semi-structured data structures, such as Extensible Markup Language (XML) data structures, have become an industry standard mechanism to either transfer or store data. Semi-structured data structures are favored over other conventional fixed and/or application specific data structures because of the extensibility, transparency, platform-independency and manageability. These data structures allow two pieces of software programs that are independently developed to communicate with each other. However, transmission of these semi-structured data structures has at least two drawbacks, a) the size of the data structure having to be transferred and (b) the associated processing cost (especially on the receiver side).

Size: Semi-structured data structures, such as XML data structures, are typically very redundant when compared to other conventional fixed, application specific data structures. Many tag names and attribute names must be repeated over and over again. For example, it usually takes 100-300% more bytes to represent the same data in XML. In addition, it is very common that there are many

duplicate attribute values. Consider the example "Employees" XML data structure illustrated in **Fig. 4a**, the tag name "Employee" and attribute names "Employee ID" and "Title" are repeated over and over again.

Processing Cost: Semi-structured data structures, such as XML, are also very expensive to parse. Typically, the data sender either builds the data structure directly concatenating a number of strings or feeding them into a stream, or builds an object hierarchy and then serializes it into a string or stream. On the receiver side, the receiver code must then scan the data string/stream to sequentially look for space characters to tokenize, and compare each tag names and attributes with known keywords. Further, such parsing requires a lot of memory, especially if each token is stored as a separate string object.

These drawbacks are especially problematic for smaller devices with limited CPU-power and small amount of memory (such as wireless mobile phones and palm sized personal digital assistants) with lower data transmission speed. In certain applications, such as Nippon Telephone Telegraph - DoCoMo's iMode, the operation cost can be significantly higher, as the application operator charges for the service on a per-packet basis.

Thus, a more efficient approach to transmitting such data structures is desired.

SUMMARY OF THE INVENTION

In accordance with a first aspect of the present invention, a data transmitter is designed to receive constituting elements of a data structure, determine occurrence frequency of each unique constituting element in the data structure, assign a cookie representation to each of the unique constituting elements based at least in part on the occurrence frequencies of the unique constituting elements, and transmit the data structure implicitly in a substantively equivalent form that allows a receiver of the data structure in the substantively equivalent form to be able to reconstitute the data structure using the occurrence frequency based cookie representations.

In accordance with another aspect of the present invention, a data receiver is designed to receive unique constituting elements of a data structure transmitted in a pre-determined manner, infer corresponding cookie representations for the received unique constituting elements in accordance with their manner of transmissions under the pre-determined manner of transmission, and receive the constituting elements of the data structure in a representative form. In one embodiment, the data reeiver is further designed to reconstitute the constituting elements of the data structure, received in the representative form, based on the inferred cookie representations.

In one embodiment, the data structure is a XML data structure. The constituting elements include tag names, attribute names, and attritbute values.

In one embodiment, a digital device is provided with the data transmitter. In another embodiment, a digital device is provided with the data receiver. In yet another embodiment, a digital device is provided with both.

In one embodiment, the digital device is a wireless mobile phone. In another, the digital device is a palm sized personal digital assistant, a notebook sized computer, a desktop computer, a set top box, or a server.

BRIEF DESCRIPTION OF DRAWINGS

The present invention will be described by way of exemplary embodiments, but not limitations, illustrated in the accompanying drawings in which like references denote similar elements, and in which:

Figure 1 illustrates an overview of the present invention, in accordance with one embodiment;

Figures 2a-2b illustrate a method view of the present invention, in accordance with one embodiment;

Figures 3a-3c illustrate example data structures suitable for use to practice the present invention, in accordance with one embodiment;

Figures 4a-4g illustrate an example application of the present invention to the transmission of an example XML data structure; and

Figure 5 illustrates an architectural view of an example computing device, suitable for practicing the present invention, in accordance with one embodiment.

DETAILED DESCRIPTION OF THE INVENTION

In the following description, various aspects of the present invention will be described. However, it will be apparent to those skilled in the art that the present invention may be practiced with only some or all aspects of the present invention. For purposes of explanation, specific numbers, materials and configurations are set forth in order to provide a thorough understanding of the present invention. However, it will also be apparent to one skilled in the art that the present invention may be

practiced without the specific details. In other instances, well known features are omitted or simplified in order not to obscure the present invention.

Parts of the description will be presented using terms such as data structures, tag names, attribute names, and so forth, commonly employed by those skilled in the art to convey the substance of their work to others skilled in the art. Parts of the description will be presented in terms of operations performed by a computing device, using terms such as receiving, determining, transmitting, and so forth. As well understood by those skilled in the art, these quantities and operations take the form of electrical, magnetic, or optical signals capable of being stored, transferred, combined, and otherwise manipulated through mechanical and electrical components of a digital system. The term digital system includes general purpose as well as special purpose computing machines, systems, and the like, that are standalone, adjunct or embedded.

Various operations will be described in turn in a manner that is most helpful in understanding the present invention, however, the order of description should not be construed as to imply that these operations are necessarily order dependent. Furthermore, the phrase "in one embodiment" will be used repeatedly, however the phrase does not necessarily refer to the same embodiment, although it may.

Overview

Referring now to **Figure 1**, wherein a block diagram illustrating an overview of the present invention, in accordance with one embodiment is shown. As illustrated, in accordance with one aspect of the present invention, data sender system **102** is advantageously provided with data transmitter **108** of the present invention, to assist a data sending application, such as data sender **104**, to transmit semi-structured data structures, such as XML data structures, as represented by

data structures **106**, in a more efficient, compact, and bandwidth reduced manner. As will be described in more detail below, data transmitter **108** effectuates transmission of data structures **106** in the desired manner, by transmitting occurrence frequency based cookie representations of the "tokens", i.e. data elements, of data structures **106** instead. For the illustrated embodiment, the novel transmission of the occurrence frequency based cookie reprensentations are performed, employinig dictionary **110** and array **112**. As will be described in more detail below, dictionary **110** is employed to store the occurrence frequency based cookie representations for encoding the "tokens", whereas array **112** is used to store the encoded "tokens", i.e. their cookie representations.

In accordance with another aspect of the present invention, data receiver system **114** is advantageously provided with complementarilty equipped data receiver **116** to assist the ultimate data recipient **118** in receiving data structure **106** transmitted in the above described efficient manner. For the illustrated embodiment, data receiver **116** effectuates the assistance employing dictionary **110'**, which as will be described in more detail beliow, is provided by data transmitter **108**.

Except for the respective provisions of data transmitter **108** and data receiver **116** to sender system **102** and receiver system **114**, sender system **102** and receiver system **114** are otherwise intended to represent a broad range of digital devices known in the art, including but are not limited to, wireless mobile phones, palm sized personal digital assistants, notebook sized computers, desktop computers, set-top boxes, servers, and the like. Of course, sender system **102** and receiver system **114** may also be further provided with data receiver **116** and data transmitter **108** respectively, allowing these systems to function in the role of a data sender at one point in time, and in the role of a data receiver at another point in time. For these embodiments, of course data transmitter **108** and data receiver **116**

may be provided as a combined unit or component, i.e. a data tranceiver, having both the transmission as well as the reception capabilities of the present invention. On the other hand, in alternate embodiments, data sender **104** and data transmitter **108** may be disposed in different systems. Similarly, data receiver **116** and ultimate data recipient **118** may also be disposed in different systems.

Further, sender system **102** and receiver system **114** may be coupled to each other via any one of a number of wireless or wireline based communication interfaces, using any one of a number of communication protocols. For example, the communication interface may be a wireless medium, using the TCP/IP communication protocol, signaled in accordance with the GSM, CDPD, CDMA or WCDMA signalling protocol. Alternatively, the communication may be a wireline based medium, again using the TCP/IP communication protocol, signaled in accordance with the Ethernet signalling protocol. In general, as those skilled in the art will appreciate, the present invention may be practiced in any communication/signal protocols on any communication medium.

Similarly, while for ease of understanding, the present invention will be described referencing XML data structures and examples expressed in XML, those skilled in the art would appreciate that the present invention may also be practiced on other data strcutures, including but are not limited to HTML or WML encoded contents.

Method

Referring now to **Figures 2a-2b**, wherein two block diagrams illustrating the novel data sending and receiving method of the present invention in further detail, in accordance with one embodiment, are shown. As illustrated in **Fig. 2a**, at block **202**, data sender **104** "transparently" sends constituting elements of data structure

106 (such as tag names, attribute names, and attribute values, in the case of an XML structure) in plain text, as in the prior art. That is, legacy data sender **104** may continue to send data as in the prior art without having to make any adjustments to its operation, nor having to be congnizant of the practice of the present invention. However, in alternate embodiments, data sender **104** who's cognizant of the present invention, may further take advantage by sending the data elements of data strcuture **106** in token form. In accordance with the present invention, the data elements are received by data transmitter **108** and turn into token form if received in the plain text form. Data transmitter **108** would parse the received data strcuture **106** to "tokenize" its data elements, using any one of a number of parsing techniques known in the art. Using example "Employees" XML data structure **400** illustrated in **Fig. 4a** as an example, as the constituting elements of example structure **400**, i.e. "<", "Employees", ">", and so forth, are sent "transparently" by data sender **104**, data transmitter **108** receives the constituting elements as "tokens", as illustrated in **Fig. 4b**.

Referring back to **Fig. 2a-2b**, at block **204**, data transmitter **108** encodes the "tokens" with cookie representations. More importantly, the cookie representations are functionally dependent on the occurrence frequencies of the unique "tokens" in data structure **106**. Using the example "Employees" XML data structure **400** illustrated in **Fig. 4a** as an example again, the constituting elements are encoded as illustrated in **Fig. 4f**, using the occurrence frequency based cookie representations of **Fig. 4e**. For example, the token ">" is encoded with the numeric cookie representation of "1", as the token ">" is the most frequently occurred token, among the tokens of example data structure **400** (8 times), the token "=" is encoded with the numeric cookie representation of "2", as the token "=" is the next most frequently occurred token, among the tokens of example data structure **400** (6 times), and so

forth. [Ties are broken arbitrarily.] In one embodiment, the encoding is a multi-step process, to be described in more detail below.

Thus, under this embodiment of the novel occurrence frequency based encoding scheme of the present invention, the most frequently occurred token is encoded with a numeric cookie representation having the lowest numeric value (relative to other numeric cookie representations employed for the data structure being transmitted), the next most frequently occurred token is encoded with a numeric cookie representation having the next lowest numeric value, and so forth.

As those skilled in the art would appreciate, under this scheme, the first 127 most frequently occurred unique tokens may be transmitted employing one byte of bandwidth for each token, that is with each token as a datum with a size of one byte, whereas the next 32,640 most frequently occurred unique tokens may be transmitted employing two bytes of bandwidth for each token, that is with each token as a datum with a size of two bytes. The two formats may be differentiated e.g. using the most significant bit. As a result, a data structure may be advantageously transmitted with further reduction in bandwidth required, as the more frequently occurred tokens are transmitted with one byte encodings, while only the less frequently occurred tokens are transmitted with two byte encodings.

Referring back again to **Fig. 2a-2b**, at block **206**, data transmitter **108** transmits the unique "tokens" and "conveys" their cookie representations to data receiver **116**. In one embodiment, the cookie representations of the "tokens" are implicitly conveyed. That is, the cookie representation are not explicitly transmitted. Instead, the unique "tokens" are transmitted in a pre-determined manner, and data receiver **116** infers the cookie representations from the manner the unique "tokens" are transmitted under the predetermined manner. Again referring to the example encoding illustrated in **Fig. 4e**, the tokens ">", "Employees", and so forth, are

transmitted in order of their occurrence frequencies, accordingly their cookie representations, i.e. "1", "2", and so forth, may be inferred from the transmission positions of the tokens.

Thereafer, at block **208**, data transmitter **108** transmits the "tokens" in their encoded representative form. In one embodiment, data transmitter **108** transmits the tokens (implicitly conveying their encodings), and the encoded representations as one contiguous string or stream (to be described more fully below). At block **210**, upon receipt of the list of unique tokens (and their encodings), and the encoded representations, data receiver **116** reconstitutes the original data structure, i.e. regenerating the original data elements based on the received encoding representations and the unique tokens (and their corresponding encoding representations), for ultimate data recipient **118**. As a result, the amount of processing required on the receiver side to accept the transmitted data structure is also significantly reduced. Further, by remapping the tokens back to the original data elements, the method may be made transparent to legacy data receivers. However, in alternate embodiments, data recipients **118** cognizant of data receivers **116** may further take advantage of the present invention, and reduces its storage employed to store received data strcutures by having data reciever **116** provides the received data structure in the token form, without reconstituting the original data elements.

Figure 2b illustrates the encoding operation of block **204** in further details, in accordance with one embodiment. As illustrated, at blocks **222** and **224**, data transmitter **108** first encodes the tokens with an initial encoding as the tokens are received/identified, and stores the received/identified tokens in their representative form. Additionally, data transmitter **108** tracks each of the unique tokens encountered, its initial encoding, and more importantly, the occurrence frequency of

each of the unqiue tokens. For the illustrated embodiment, the intial encoding is simply the order the unique tokens are encountered. For example, for the example "Employee" XML data structure **400** of **Fig. 4a**, the initial encoding employed is as illustrated in **Fig. 4c**. That is, token "<" is encoded with the numeric cookie representation of "0", as it is encountered first, token "Employees" is encoded with the numeric cookie represenation of "1", as it is encountered next, and so forth. Thus, example "Employee" XML data structure **400** may be stored in a representative form in array **430a** (corresponding to array **112** of **Fig. 1**) as illustrated in **Fig. 4d**.

Thus, upon receipt of all tokens, i.e. data elements of the data structure being transmitted, the occurrence frequncies of the unique tokens of the data structure would be established. For the example XML data strcuture **400**, it would have established that token "<" occurs 4 times, token "Employees" occurs once, token ">" occurs 8 times (the most frequent), and so forth, as illustrated in **Fig. 4c**.

Thereafter, at blocks **226** and **228**, data transmitter **108** replaces the initial cookie representations with replacement cookie representations that are functionally dependent on the occurrence frequency of the unique tokens, and the stored "tokens" in their representative form are re-mapped to new representations. For example, the replacement cookie representation of "1" is assigned to replace the initial cookie representation of "2" for the most frequently occurred token ">",the replacement cookie representation of "2" is assigned to replace the initial cookie representation of "6" for the second most frequently occurred token "=", and so forth. Correspondingly, the stored tokens in their initial representations (**Fig. 4d**) are re-mapped to the replacement representations (**Fig. 4f**). The remapping e.g. may be performed with the assistance of a remapping vector (not shown), which is known in the art.

Thus, it can be seen that the encoding or compression operations of the present invention may be performed in a relatively straight forward manner, with relative low memory and processing requirements. As a result, the amount of memory and proecssing required on the sender side to "compress" the data elements for transmission (to achieve the desired bandwidth consumption reduction), under the present invention, is also advanageously smaller than other compression techniques known in the art, such as "Zip".

Data Structures

Figures 3a-3c illustrate a number of example data structures suitable for use to practice the present invention, in accordance with one embodiment. Shown in **Figure 3a** is example table **300** having at least three columns **302-306**, suitable for use by data transmitter **108** to store the cookie representations (initial as well as final for the earlier described two steps embodiment), the represented tokens, and their occurrence frequencies. An abridged version of example table **300**, without column **306** may be used by data receiver **116** to store the cookie representations, and the represented unique tokens. Shown in **Figure 3b** is example array **310** having a number storage slots suitable for use by data transmitter **108** to stored the encoded representations (c0, c1, c2 etc.) of the tokens of a data structure being transmitted. Shown in **Figure 3c** is example string or stream **320** having two sections **322** and **326**, separated by delimiters **324a-324b**, suitable for use by data transmitter **108** to transmit the unique tokens (and implicitly convey their encoding representations), and the encoded representaions of the tokens of a data structure being transmitted. For the illustrated embodiment, first section **322** is employed to transmit the unique tokens (and implicitly convey their encoding representations). Each unique token is preceded by the token size. For example, the token "<" is

preceded by the token size value of "0x01", the token "</" is preceded by the token size "0x02", and so forth (as illustrated in **Fig. 4g**). The encoding representation for the token "<" is "1", as implied by the fact that the token is transmitted in the first transmission position, the encoding representation for the token "</" is "3", as implied by the fact that the token is transmitted in the third transmission position, and forth. Referring back to **Fig. 3c**, as illustrated, second section **326** is employed to transmit the encoded representations of the tokens of the data structure being transmitted.

Example Digital Device

Figure 5 illustrates an example computing device suitable for use to practice the present invention, in accordance with one embodiment. As shown, computing device **500** includes general purpose processor **502**, digital signal processor (DSP) **504**, and system memory **506**. Additionally, device or system **500** includes GPIO **508** (for interfacing with I/O devices such as keyboard, cursor control and so forth) and communication interfaces **510** (such as network interface cards, modems, wireless transceivers and so forth). The elements are coupled to each other via system bus **512**, which represents one or more buses. In the case of multiple buses, they are bridged by one or more bus bridges (not shown). More importantly, device or system **500** is provided with data transceiver **514** incorporated with the teachings of the present invention to send and receive data structures in the above described more efficient constituting element occurrence frequency based compression form.

The number and type of processor, the size of memory, as well as the number of other elements employed are typically dependent on the intended usage of example computing device **500**. For example, if used as a wireless mobile

telephone or a palm sized personal digital assistant, probably a relatively lower performance processor and smaller amount of memory are used. On the other hand, if used as a notebook computer or a set top box, probably a relatively higher performance processor and more amount of memory are used, and may be even with the additional employment of mass storage devices. If used as a desktop computer or a server, probably even multiple high performance processors are employed, but may be without the employment of DSP **504** instead.

Each of these elements performs its conventional functions known in the art. In particular, system memory **504** is employed to store a copy of the programming instructions implementing data transceiver **514**. Except for its use to host novel data transceiver **514** incorporated with the transmit and receive teachings of the present invention, the constitution of these elements **502-512** are known, and accordingly will not be further described.

Conclusion and Epilogue

Accordingly, a method and apparatus for sending and receiving a data structure in a constituting element occurrence frequency based compressed form has been described. As mentioned earlier, the present invention significantly reduces the number of bytes required to be transmitted, as well as the amount of memory and the amount of processing required on the sender and the receiver systems.

While the present invention has been described in terms of the above illustrated embodiments, those skilled in the art will recognize that the invention is not limited to the embodiments described. The present invention can be practiced with modification and alteration within the spirit and scope of the appended claims. Thus, the description is to be regarded as illustrative instead of restrictive on the present invention.

CLAIMS

What is claimed is:

1. A method comprising:

receiving a plurality of constituting elements of a data structure;

determining occurrence frequency of each unique constituting element in said data structure;

assigning a cookie representation to each of said unique constituting elements based at least in part on the occurrence frequencies of said unique constituting elements; and

transmitting said data structure implicitly in a substantively equivalent form that allows a receiver of said data structure in said substantively equivalent form to be able to reconstitute the data structure using said occurrence frequency based cookie representations.

2. The method of claim 1, wherein said determining and assigning comprises assigning an initial cookie representation to each unique constituting element as the constituting elements are received, and tracking occurrence frequencies of the unique constituting elements, and upon receipt of all constituting elements of the data structure, re-assigning a final cookie representation for each of the unique constituting elements based on the occurrence frequencies of the unique constituting elements.

3. The method of claim 2, wherein the method further comprises ordering said unique constituting elements based on their occurrence frequencies.

4. The method of claim 2, wherein the method further comprises storing said constituting elements of the data structure as they are received, using said initial cookie representations, and subsequently replacing the stored initial cookie representations with the final cookie representations, and said transmitting comprises transmitting said constituting elements of said data structure using said final cookie representations.

5. The method of claim 4, wherein said transmitting further comprises transmitting a list of said unique constituting elements in the order of their occurrence frequencies to allow the receiver to infer the corresponding final cookie representations of the unique constituting elements.

6. The method of claim 1, wherein the cookie representations are numeric in form, with the cookie representations of the 128 most frequently occurred unique constituting elements having a size of one byte each, and the cookie representations of the next 32,640 most frequently occurred unique constituting elements having a size of two bytes each.

7. The method of claim 1, wherein said data structure is an XML data structure, and said constituting elements comprise tag names, attribute names and attribute values.

8. A method comprising:

receiving a plurality of unique constituting elements of a data structure transmitted in a pre-determined manner;

inferring a plurality of corresponding cookie representations for the received unique constituting elements in accordance with their manner of transmissions under the pre-determined manner of transmission; and

receiving the constituting elements of the data structure in a representative form.

9. The method of claim 8, wherein said inferring comprises inferring the plurality of corresponding cookie representations based on the order the unique constituting elements are transmitted.

10. The method of claim 9, wherein said inferring comprises inferring a unique one-byte numeric representation for each of the first 128 unique constituting elements transmitted, and a unique two-bytes representation for each of the next 32,460 unique constituting elements transmitted.

11. The method of claim 8, wherein the method further comprises reconstituting the constituting elements of the data structure, received in said representative form, based on the inferred cookie representations.

12. The method of claim 8, wherein said data structure is an XML data structure, and said constituting elements comprises tag names, attribute names and attribute values.

13. An apparatus comprising:

storage medium having stored therein a plurality of programming instructions designed to receive a plurality of constituting elements of a data structure, determine occurrence frequency of each unique constituting element in said data structure, assign a cookie representation to each of said unique constituting elements based at least in part on the occurrence frequencies of said unique constituting elements, and transmit said data structure implicitly in a substantively equivalent form that allows a receiver of said data structure in said substantively equivalent form to be able to reconstitute the data structure using said occurrence frequency based cookie representations; and

at least one processor coupled to the storage medium to execute the programming instructions.

14. The apparatus of claim 13, wherein said programming instructions are designed to perform said determining and assigning by assigning an initial cookie representation to each unique constituting element as the constituting elements are received, and tracking occurrence frequencies of the unique constituting elements, and upon receipt of all constituting elements of the data structure, re-assigning a final cookie representation for each of the unique constituting elements based on the occurrence frequencies of the unique constituting elements.

15. The apparatus of claim 14, wherein the programming instructions are further designed to order said unique constituting elements based on their occurrence frequencies.

16. The apparatus of claim 14, wherein the programming instructions are further designed to store said constituting elements of the data structure as they are

received, using said initial cookie representations, and subsequently replace the stored initial cookie representations with the final cookie representations, and said programming instructions perform said transmitting by transmitting said constituting elements of said data structure using said final cookie representations.

17. The apparatus of claim 16, wherein said programming instructions are further designed to transmit a list of said unique constituting elements in the order of their occurrence frequencies to allow the receiver to infer the corresponding final cookie representations of the unique constituting elements.

18. The apparatus of claim 13, wherein the programming instructions are deigned to employ cookie representations in numeric form, with the cookie representations of the 128 most frequently occurred unique constituting elements having a size of one byte each, and the cookie representations of the next 32,640 most frequently occurred unique constituting elements having a size of two bytes each.

19. The apparatus of claim 13, wherein said programming instructions are designed to perform said receive, determine, assign and transmit for an XML data structure, said constituting elements comprising tag names, attribute names and attribute values.

20. The apparatus of claim 13, wherein said apparatus is a selected one of a wireless mobile phone, a palm sized personal digital assistant, a notebook sized computer, a desktop computer, a set top box and a server.

21. An apparatus comprising:

storage medium having stored therein a plurality of programming instructions designed to receive a plurality of unique constituting elements of a data structure transmitted in a pre-determined manner, infer a plurality of corresponding cookie representations for the received unique constituting elements in accordance with their manner of transmissions under the pre-determined manner of transmission, and receive the constituting elements of the data structure in a representative form; and

at least one processor coupled to the storage medium to execute the programming instructions.

22. The apparatus of claim 21, wherein said programming instructions are designed to infer the plurality of corresponding cookie representations based on the order the unique constituting elements are transmitted.

23. The apparatus of claim 22, wherein said programming instructions are designed to infer a unique one-byte numeric representation for each of the first 128 unique constituting elements transmitted, and a unique two-bytes representation for each of the next 32,460 unique constituting elements transmitted.

24. The apparatus of claim 21, wherein said programming instructions are further designed to reconstitute the constituting elements of the data structure, received in said representative form, based on the inferred cookie representations.

25. The apparatus of claim 21, wherein said programming instructions are designed to perform said receive, infer, receive, and re-constitute for a XML data

structure, said constituting elements comprising tag names, attribute names and attribute values.

26. The apparatus of claim 21, wherein said apparatus is a selected one of a wireless mobile phone, a palm sized personal digital assistant, a notebook sized computer, a desktop computer, a set top box and a server.

Attorney Docket No. 41020.P003

Method and Apparatus for Sending and Receiving A Data Structure in a Constituting Element Occurrence Frequency Based Compressed Form

ABSTRACT OF THE DISCLOSURE

In accordance with a first aspect of the present invention, a digital device is provided with a data transmitter designed to receive constituting elements of a data structure, determine occurrence frequency of each unique constituting element in the data structure, assign a cookie representation to each of the unique constituting elements based at least in part on the occurrence frequencies of the unique constituting elements, and transmit the data structure implicitly in a substantively equivalent form that allows a receiver of the data structure in the substantively equivalent form to be able to reconstitute the data structure using the occurrence frequency based cookie representations. In accordance with another aspect of the present invention, a digital device is provided with a data receiver designed to receive unique constituting elements of a data structure transmitted in a pre-determined manner, infer corresponding cookie representations for the received unique constituting elements in accordance with their manner of transmissions under the pre-determined manner of transmission, and receive the constituting elements of the data structure in a representative form. In one embodiment, the data receiver is further designed to reconstitute the constituting elements of the data structure, received in the representative form, based on the inferred cookie representations.

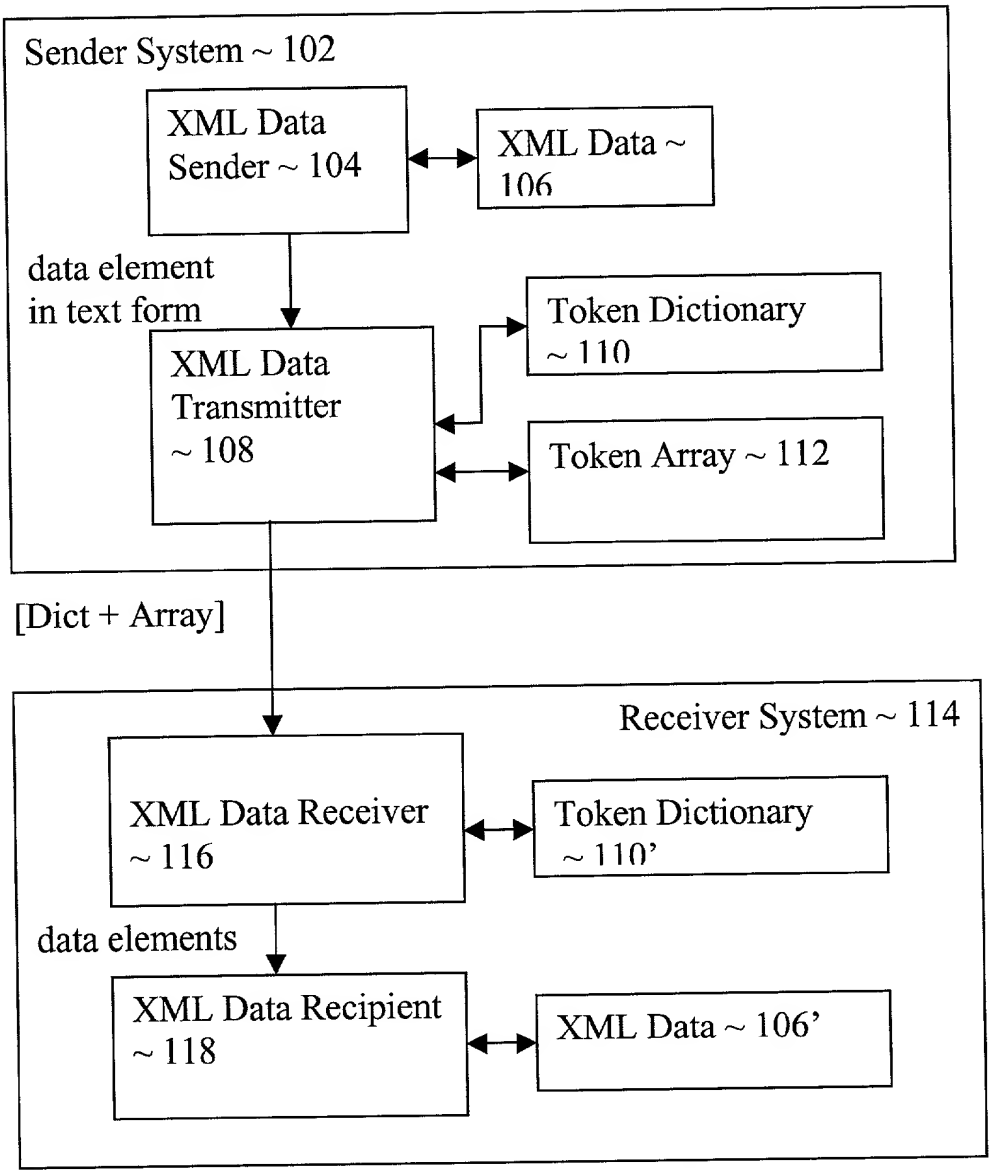
Sender System ~ 102
XML Data Sender ~ 104
XML Data ~ 106
data element in text form
XML Data Transmitter ~ 108
Token Dictionary ~ 110
Token Array ~ 112
[Dict + Array]
Receiver System ~ 114
XML Data Receiver ~ 116
Token Dictionary ~ 110'
data elements
XML Data Recipient ~ 118
XML Data ~ 106'

Figure 1

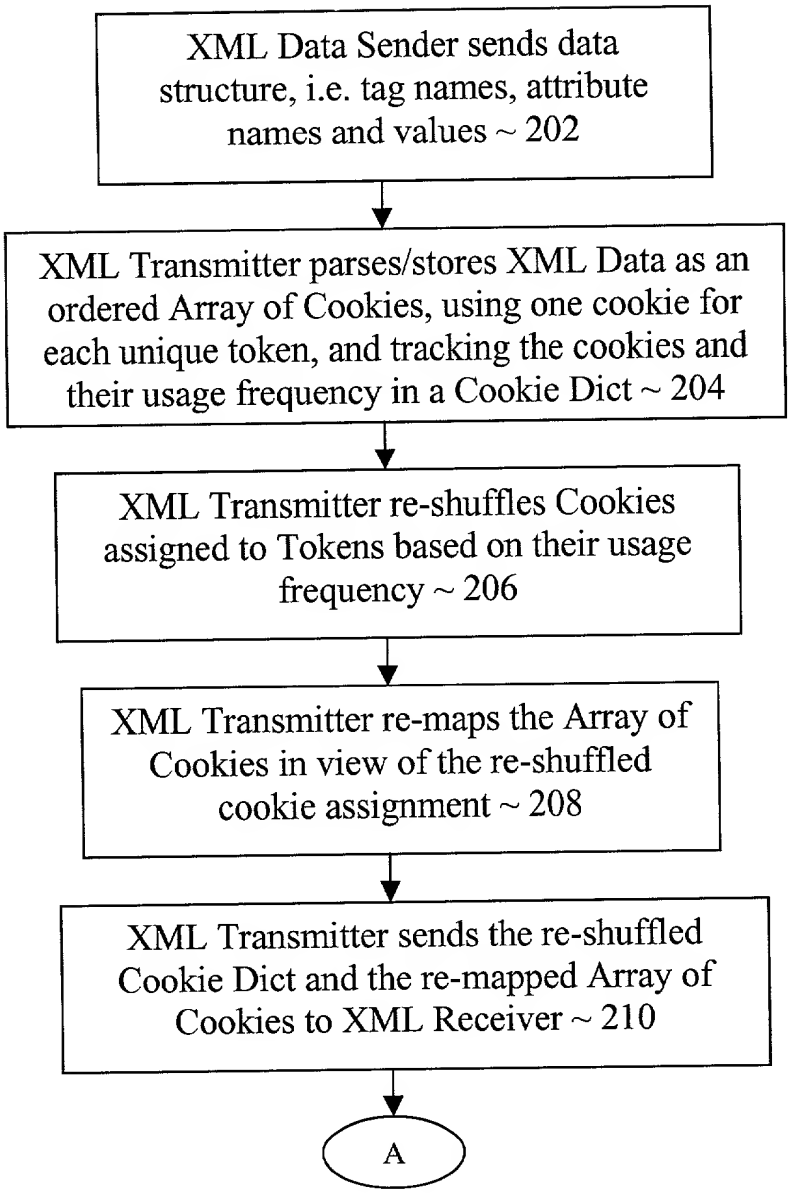
XML Data Sender sends data structure, i.e. tag names, attribute names and values ~ 202
XML Transmitter parses/stores XML Data as an ordered Array of Cookies, using one cookie for each unique token, and tracking the cookies and their usage frequency in a Cookie Dict ~ 204
XML Transmitter re-shuffles Cookies assigned to Tokens based on their usage frequency ~ 206
XML Transmitter re-maps the Array of Cookies in view of the re-shuffled cookie assignment ~ 208
XML Transmitter sends the re-shuffled Cookie Dict and the re-mapped Array of Cookies to XML Receiver ~ 210
A

Figure 2a

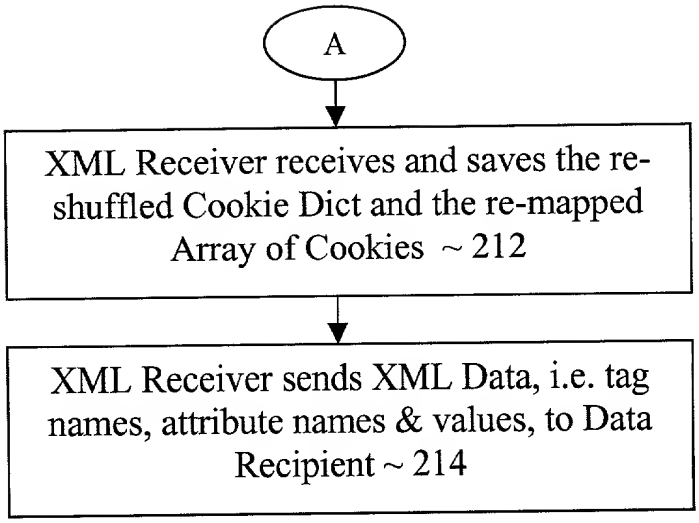
A
XML Receiver receives and saves the re-shuffled Cookie Dict and the re-mapped Array of Cookies ~ 212
XML Receiver sends XML Data, i.e. tag names, attribute names & values, to Data Recipient ~ 214

Figure 2b

300

Cookies ~ 302	Tokens ~ 304	Usage Frequency ~ 306

Figure 3a

310

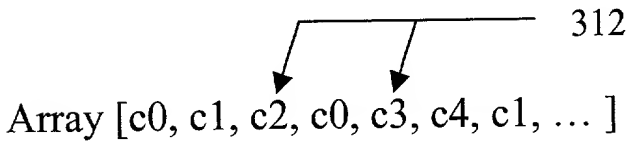

Figure 3b

400

```
<Employees>
  <Employee ID="1" Title="Software Engineer">Alex
      Rodriguez</Employee>
  <Employee ID="2" Title="Software Engineer">Jay
      Buner</Employee>
  <Employee ID="3" Title="Software Engineer">Mike
      Cameron</Employee>
</Employees>
```

Figure 4a

402

```
"<", "Employees", ">", "<", "Employee" "ID" "="
  "1"
```

Figure 4b

404

Cookie	Tokens	Frequency
0	"<"	(4)
1	"Employees"	(1)
2	">"	(8)
3	"Employee"	(3)
4	"</"	(4)
5	"ID"	(3)
6	"="	(6)
7	"1"	(1)
8	"Title"	(3)
9	"Software Engineer"	(3)
...		

Figure 4c

406

Array[] = { 0, 1, 2, 0, 3, 5, 6, … }

Figure 4d

408

Cookie	Tokens	Frequency
1	">"	(8)
2	"="	(6)
3	"Employee"	(6)
4	"<"	(4)
5	"</"	(4)
6	"ID"	(3)
7	"Software Engineer"	(3)
8	"Title"	(3)
9	"Employees"	(2)
10	"1"	(1)

…

Figure 4e

410

Array[] = { 4, 8, 1, 4, 3, 6, 10, 8, 7, … }

Figure 4f

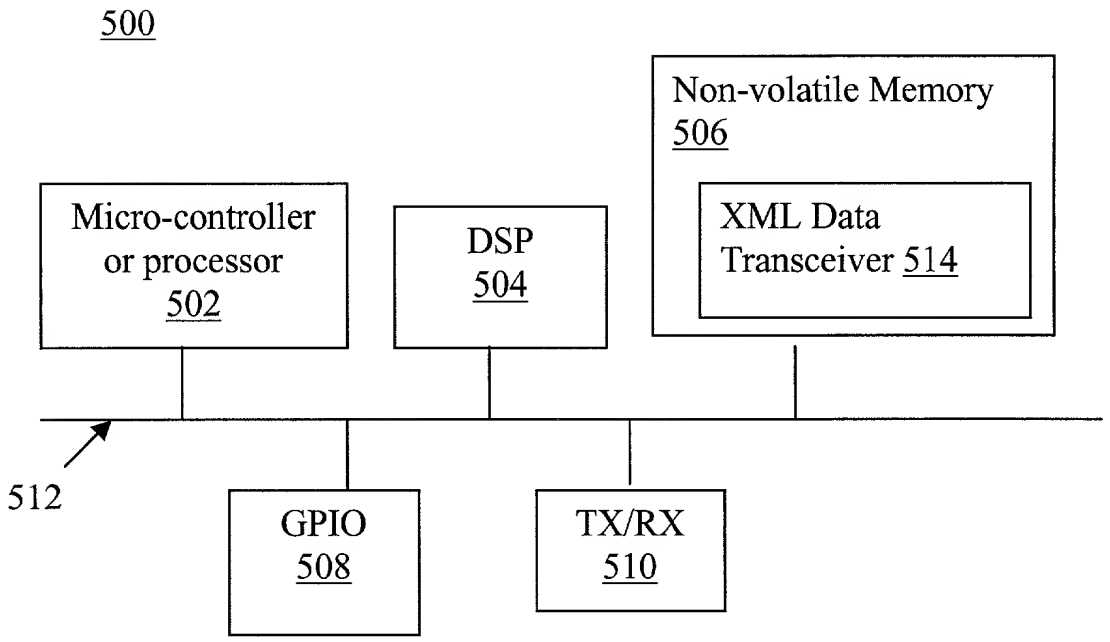
500
Non-volatile Memory
506
XML Data
Transceiver 514
Micro-controller
or processor
502
DSP
504
512
GPIO
508
TX/RX
510

Figure 5

Attorney's Docket No 41020 P003 PATENT

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that.

My residence, post office address and citizenship are as stated below, next to my name.

I believe I am the original, first, and sole inventor (if only one name is listed below) or an original, first, and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

Method and Apparatus For Sending and Receiving A Data Structure In A Constituting Element Occurrence Frequency Based Compressed Form

the specification of which

X is attached hereto.
___ was filed on _____ as
United States Application Number _____
or PCT International Application Number _____
and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claim(s), as amended by any amendment referred to above.

I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d), of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)			Priority Claimed	
(Number)	(Country)	(Day/Month/Year Filed)	Yes	No
(Number)	(Country)	(Day/Month/Year Filed)	Yes	No
(Number)	(Country)	(Day/Month/Year Filed)	Yes	No

I hereby claim the benefit under title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below

(Application Number) Filing Date

(Application Number) Filing Date

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph

of Title 35, United States Code, Section 112, I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Number)	Filing Date	(Status -- patented, pending, abandoned)
(Application Number)	Filing Date	(Status -- patented, pending, abandoned)

I hereby appoint Aloysius T. C. AuYeung, Reg. No. 35,432; Robert A. Diehl, Reg. No. 40,992, Jason K. Klindtworth (Reg No. P47,211) and Robert T Watt (Reg. No. 45,890) my patent attorney/agent; with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected herewith.

Send correspondence to Aloysius T C. AuYeung (Name of Attorney or Agent),
Columbia IP Law Group, LLC, 4900 SW Meadows Rd., Suite 109, Lake Oswego, OR 97035.
and direct telephone calls to Aloysius T C. AuYeung (Name of Attorney or Agent), (503) 534-2800.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full Name of Sole/First Inventor Satoshi Nakajima

Inventor's Signature _____ Date 11/6/2000

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Title 37, Code of Federal Regulations, Section 1.56
Duty to Disclose Information Material to Patentability

(a) A patent by its very nature is affected with a public interest The public interest is best served, and the most effective patent examination occurs when, at the time an application is being examined, the Office is aware of and evaluates the teachings of all information material to patentability. Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith in dealing with the Office, which includes a duty to disclose to the Office all information known to that individual to be material to patentability as defined in this section. The duty to disclosure information exists with respect to each pending claim until the claim is cancelled or withdrawn from consideration, or the application becomes abandoned. Information material to the patentability of a claim that is cancelled or withdrawn from consideration need not be submitted if the information is not material to the patentability of any claim remaining under consideration in the application. There is no duty to submit information which is not material to the patentability of any existing claim The duty to disclosure all information known to be material to patentability is deemed to be satisfied if all information known to be material to patentability of any claim issued in a patent was cited by the Office or submitted to the Office in the manner prescribed by §§1.97(b)-(d) and 1.98. However, no patent will be granted on an application in connection with which fraud on the Office was practiced or attempted or the duty of disclosure was violated through bad faith or intentional misconduct. The Office encourages applicants to carefully examine:

(1) Prior art cited in search reports of a foreign patent office in a counterpart application, and

(2) The closest information over which individuals associated with the filing or prosecution of a patent application believe any pending claim patentably defines, to make sure that any material information contained therein is disclosed to the Office.

(b) Under this section, information is material to patentability when it is not cumulative to information already of record or being made or record in the application, and

(1) It establishes, by itself or in combination with other information, a prima facie case of unpatentability of a claim; or

(2) It refutes, or is inconsistent with, a position the applicant takes in.

(i) Opposing an argument of unpatentability relied on by the Office, or

(ii) Asserting an argument of patentability.

A prima facie case of unpatentability is established when the information compels a conclusion that a claim is unpatentable under the preponderance of evidence, burden-of-proof standard, giving each term in the claim its broadest reasonable construction consistent with the specification, and before any consideration is given to evidence which may be submitted in an attempt to establish a contrary conclusion of patentability

(c) Individuals associated with the filing or prosecution of a patent application within the meaning of this section are.

(1) Each inventor named in the application;

(2) Each attorney or agent who prepares or prosecutes the application; and

(3) Every other person who is substantively involved in the preparation or prosecution of the application and who is associated with the inventor, with the assignee or with anyone to whom there is an obligation to assign the application.

(d) Individuals other than the attorney, agent or inventor may comply with this section by disclosing information to the attorney, agent, or inventor